A Multiphasic Screening Survey in San Jose

C. KELLY CANELO, M.D., and DWIGHT M. BISSELL, M.D., *San Jose;* and
HERBERT ABRAMS, M.D., and LESTER BRESLOW, M.D., *Berkeley*

SUMMARY

In the interest of economy and of better service to the persons examined, three screening tests of a kind usually made separately were combined and applied in a single examination of 945 employees in four industrial establishments. Miniature x-ray films of the chest were taken, blood specimens drawn and urine samples obtained so that studies and tests might be made to determine the presence of pulmonary or cardiac disease, syphilis, kidney disease, or diabetes. The history of each person examined was taken.

Through this multiphasic survey, 13 cases of significant disease previously unknown to the patient were discovered. Sixteen cases of significant disease, previously known, were also disclosed; and in several such cases treatment was begun or resumed.

The results in case finding were considerably greater than those of the customary screening for a single disease.

MASS screening programs in the fields of tuberculosis and syphilis are well established. The miniature photofluorographic technique and the improved serologic tests for syphilis have permitted health agencies to screen large populations for the presence of signs indicative of these diseases. These mass detection techniques represent great contributions to the campaigns for the control of tuberculosis and syphilis.

Recently screening techniques have been developed in the fields of diabetes and heart disease. Wilkerson and Krall[1] demonstrated in Oxford, Mass., the feasibility of a community-wide diabetes detection program based upon screening tests for blood-sugar level and glycosuria, with referral of suspicious cases for final diagnostic study. In the community studied 40 cases of diabetes were previously known to the physicians in practice there. Through the survey 30 new cases were discovered among the 3,516 persons tested. The total number of cases found indicated that the incidence of diabetes in the general population was 1.7 per cent. This means that there are approximately 2,000,000 cases of diabetes in the United States, a higher figure than ever before estimated.

Heart disease has also been shown amenable to a mass detection program. The miniature chest x-ray films taken during the course of a regular tuberculosis case-finding program in Los Angeles were interpreted specifically for the presence of cardiac abnormality. Approximately 2 per cent of the group surveyed with small films were found to have heart shadows which appeared enlarged or changed in contour. Follow-up examinations of this group disclosed that approximately one-half of them, or 1 per cent of the total adult population screened, had clinically significant, previously unknown heart disease. Obviously not all heart disease can be detected through such a radiographic survey, inasmuch as in many cases of heart disease the heart shadow is not abnormal. However, the fact remains that a substantial number (1 per cent) of people were found to have heart disease which was previously unknown to themselves and which required the care of a physician.

Thus, tuberculosis, syphilis, diabetes and heart disease have been proved detectable in the general population on a mass scale. Heretofore these screening procedures have been carried out for the most part separately. It has not been uncommon for a group of industrial employees to be surveyed for tuberculosis and then surveyed again a few months later for syphilis.

The multiphasic survey was conceived with a view to combining several of these tests in one "package." Such a combination accomplishes two purposes: First, economy, and second, a better service to the persons screened. There would be a considerable saving in the time and money of the sponsoring agencies if there could be a single health education campaign, record system and follow-up service for a screening program embracing several diseases, rather than the establishment of administrative machinery for each one separately. The individual participant and the physician to whom he was referred would have much more useful information concerning his health status from such a multiphasic survey than would be obtained from any single test. The loss of time from occupation would also be not much greater for a series of tests than it would be for any one alone.

With these considerations in mind, the Santa Clara County Medical Society, the San Jose City Health Department, and the California Department of Public Health undertook a multiphasic survey among the industrial employees in four San Jose

Santa Clara County Medical Society Multiphasic Survey Committee (Canelo); San Jose City Health Officer (Bissell); Chief, Bureau of Adult Health, California State Department of Public Health (Abrams); Chief, Chronic Disease Service, California State Department of Public Health (Breslow).

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establishments. Committees of the medical society took an active part in planning all details of the program, in assembling physicians to draw the blood specimens, in the interpretation of the x-ray films and in the conduct of follow-up activities. The San Jose City Health Department supplied the services of its health educator, its nursing staff for history-taking and follow-up services, laboratory personnel and a laboratory for the performance of the blood sugar determinations. The State Department of Public Health assisted in planning of the study, furnished some physician and nurse time, provided some funds for laboratory services, furnished the x-ray machine and personnel, and performed the serologic tests for syphilis.

The close cooperation between the county medical society and the public health agencies is worthy of special note. The county medical society did much more than give formal approval to the project; it played a real part in policy formation and the members devoted many hours to the details of the project.

In all, 945 employees at four industrial plants were screened. These plants included a department store, two units of a large food machinery corporation and an establishment manufacturing paper labels. The management and the industrial physicians of these establishments agreed that findings concerning individual participants in the study would be handled confidentially with the employees. Cooperation of employees was enlisted through printed educational materials and talks with union leaders and memberships. An intensive health education campaign in each plant culminated in an advance sign-up of individuals who wished to participate in the survey. This advance sign-up was to facilitate operations at the time tests were carried out.

The occupational range of employees was wide, including manual and clerical workers, unskilled labor, skilled labor and executives. Table 1 shows the age and sex distribution of those screened. A predominance of males in the age group 25 to 64 years will be noted.

A survey team went to each of the four plants. Five procedures were performed on the premises: A brief history taken, a blood specimen drawn, a urine specimen secured, a miniature chest x-ray taken and urinalysis performed. When the participant came to the first table in the examination line, his history form on which certain identifying information had been entered during the advance sign-up was pulled from the files; the details of the history were then completed by a public health nurse. Particular attention was given to familial incidence and symptoms of the diseases under consideration. Note was made of the amount of food consumed at and time-interval since the last meal. A quadruplicate numbering device was used so that the same number could be stamped on the history form, on the labels for the two blood specimen bottles and on the label for the urine specimen bottle. Approximately 10 cc. of venous blood was taken from each person and the specimen divided equally between two vials; the one for the blood sugar determination contained a small amount of oxalate and was immediately shaken; the other was allowed to clot for the serologic test for syphilis. The person next entered an x-ray unit parked nearby, and lastly deposited a urine specimen.

Since it was important that the blood and urine specimens be taken within one to two hours following meals the number of persons scheduled was limited to approximately 50 to 75 from 8 a.m. to 9:30 a.m. and to about the same number in the afternoon from 1 to 2:30. Employees had been advised during the educational program before the survey to eat an amount of food for breakfast or lunch sufficient to equal 50 grams of carbohydrate.

Personnel included one clerk to handle the history cards and stamp identifying numbers; public health nurses to take histories; physicians to draw the blood specimens; volunteer workers to assist with the blood specimen tubes; an x-ray technician; one technician to carry out the urine sugar and albumin tests in the plant; and two laboratory technicians to perform the blood sugar determinations.

Urinalysis was performed at the plants. The survey team brought necessary supplies and equipment for the Benedict test for sugar, and the Roberts test for albumin. Blood sugar content was determined by the standard Folin-Wu method in the city health department laboratory. The serologic tests for syphilis were carried out by the State Department of Public Health laboratory. Chest x-ray films were interpreted by two radiologists, members of the Santa Clara County Medical Society.

Criteria used for follow-up were these:

Blood sugar—160 mg. per 100 cc. or over (130 mg. if the participant had eaten less than the required amount of food, or more than two hours before the test).
Urine sugar—positive or trace.
Urine albumin—positive or trace.
Serologic test for syphilis—positive or doubtful.
Chest x-ray film—lung or heart abnormalities.

A person who met any of these criteria was informed by letter that he should visit his own doctor for further examination. The doctor designated by the employee at the time of the screening test was given the findings and requested to inform the county medical society of the final result of his examination. The medical society also provided each doctor a brief statement of suggestions con-

TABLE 1.—*Age-Sex Distribution of Participants*
San Jose Multiphasic Survey

Age	Male	Female	Total
15-24	59	55	114
25-44	395	123	518
45-64	223	68	291
65+	17	2	19
	694	248	942

cerning the diagnosis of the diseases under consideration. Persons who did not name a physician at the time of the survey or who did not report to the physician after a brief period were visited at home by a public health nurse from the health department in order to assure follow-up examinations.

Results of the screening tests are shown in Table 2. (From these tables have been excluded three persons whose tests showed evidence of diabetes but who subsequently were found not to be employed at the plants studied.)

Of some interest is the relatively high percentage who showed glycosuria, mostly small amounts following the meal. The high proportion of those manifesting albuminuria was due partly to the fact that there were many young females in the group and the specimens were voided specimens rather than catheterized. The lung x-rays were interpreted as suspicious in a somewhat greater proportion of cases than is usual in such surveys. This may have been due in part to the fact that there did appear to be a relatively high incidence of significant old healed tuberculosis, and in part to the inclination of the radiologist to interpret the films rather closely.

Table 3 presents the summary of findings. These are based upon replies from the physicians to whom the individuals were referred, final evaluation by the survey committee in a few instances, and a search of the health department records for communicable disease cases. The finding of 15 cases of diabetes in an industrial population of less than 1,000 is not surprising in view of Wilkerson and Krall's work. Nine of these cases were previously unknown either to the patients themselves or to their physicians. Of the six cases of diabetes that were previously known, at least two were not under adequate control inasmuch as the patients had blood sugar levels of more than 350 mg. per 100 cc., positive urine sugar tests and definite symptoms of the disease. Among the nine persons with newly discovered cases of diabetes, five showed blood sugar levels of more than 190 mg. per 100 cc. on the screening test, one had a blood sugar level of 180 mg. and three had levels of less than 160 mg. It is of interest to note that two of the three persons finally demonstrated to have diabetes, although the screening test had shown blood sugar less than 160 mg. per 100 cc., had either eaten less than the recommended amount of food or had gone for more than three hours since the last meal. These results confirm the impression that a content of 160 mg. per 100 cc. is an adequate criterion of suspicion of diabetes, provided the individual does digest a meal within one to two hours preceding the test.

There is considerable interest in the familial aspects of diabetes. Among the 15 cases of diabetes disclosed in this survey, six were in persons who gave a definite history of diabetes in parents or siblings, eight gave no such history, and in one case the history was unknown. This 43 per cent

TABLE 2.—*Results of Screening Tests*
San Jose Multiphasic Survey

Test	Negative	Per Cent Positive	Trace or Suspicion
Urine sugar	939	5.1	8.4
Blood sugar	917	4.3	....
Urine albumin	941	2.2	2.2
Blood test for syphilis	944	0.3	0.1
X-ray, lungs	945	....	5.2
X-ray, heart	945	....	1.4

TABLE 3.—*Summary of Findings*
San Jose Multiphasic Survey

	Previously Known	Not Previously Known	Total
Diabetes	6	9	15
Heart disease	3	..	3
Nephritis	2	2	4
Tuberculosis, active*	..	2	2
Silicosis (?)	1	..	1
Syphilis	4	..	4
	16	13	29

*Eight cases of apparently arrested tuberculosis were also disclosed.

TABLE 4.—*Blood Sugar Levels Related to Family History of Diabetes*
San Jose Multiphasic Survey

Blood Sugar	Total No.	Family History % Positive	Family History % Negative
130	752	73.1	85.5
130–159	101	11.8	11.2
160–189	27	9.7	2.2
190	14	5.4	1.1
		100.0	100.0
	894	(93)	(801)

incidence of family history of diabetes among diabetic patients may be compared with an incidence of only 10 per cent of family history of diabetes in the rest of the industrial population surveyed.

Table 4 indicates the relationship of blood sugar levels in the group surveyed to family history of diabetes. Here, again, it will be noted that the incidence of family history of diabetes was four to five times greater among those with blood sugar levels above 160 mg. per 100 cc. than in those with blood sugar below that level.

Only three cases of heart disease were disclosed, and all of these were previously known. That the findings in this field did not come up to expectations may have been due in some degree to the fact that there was less intensive follow-up of suspected cardiac cases than of suspected diabetes. It should be mentioned that, although all three cases were previously known, the survey did bring one patient back under treatment who had lapsed from care.

Two new cases of nephritis were discovered in addition to the two previously known. Two persons with new cases of apparently active tuberculosis were placed under observation as a result of the survey, as well as one with suspected silicosis.

Four persons had positive or doubtful serologic tests for syphilis. One of these was not followed; the other three were proved to have syphilis but their cases had been previously known. In addition there was one person who gave a history of being under treatment for syphilis at the time of the survey but his test was negative.

DISCUSSION

The experience here reported demonstrates the feasibility of multiphasic screening. In the future conduct of such programs, it is suggested that the criteria for referral for further diagnostic study be made somewhat higher. This would avoid the referral of a considerable number of individuals with only borderline tests and it would not significantly reduce the number of actual cases of disease finally discovered. For example, it is proposed that the finding of a trace of glycosuria be ignored unless it is accompanied by a high blood sugar level. Albuminuria in young adult females should also be ignored in screening surveys. Another way to minimize non-productive referrals would be to have the survey team repeat tests if results are borderline.

If the screening were set at a somewhat finer level than was the case in this pilot operation it is estimated that approximately 10 per cent of an apparently well adult population would be referred for definitive diagnoses. Approximately one out of three of these would be found on follow-up to have significant disease requiring continued medical care; in about half of the cases, this disease would be previously unknown. This return from a multiphasic screening survey is considerably greater than the usual experience in single-disease screening operations. When one considers the possibilities of further refinement of technique, more intensive follow-up (particularly in the case of suspected heart disease), and addition of other tests, e.g., hemoglobin determination, the value of the multiphasic screening procedure becomes even clearer.

99 South Ninth Street.

REFERENCE

1. Wilkerson, Hugh L. C., and Krall, Leo P.: Diabetes in a New England town, J.A.M.A., 135:209, Sept. 27, 1947.

Discussion by ROY O. GILBERT, M.D., *Los Angeles*

The multiphasic screening survey conducted in San Jose constitutes a type of project with which I am completely unfamiliar. I have been informed that that is the reason I have been asked to discuss this paper.

Of course, I am impressed with the ambitious nature of this survey which appears to point the way toward a diagnostic service on a mass basis that would be much in the nature of a movement to have all automobiles subjected to a multiphasic survey for defects that contribute to accidents. Such a survey should, of course, include the driver, and offers the possibility of preventing a lot of deaths and innumerable disabilities.

This pilot project has demonstrated a most commendable spirit of cooperation between the private practice of medicine and the official public health agency. From that standpoint alone I would consider the enterprise a highly successful one. However, the question may well be asked at this point, "How multiphasic can a multiphasic survey be and remain within the bounds of practical economy?" It is quite true that during the postwar years sociological thinking by a considerable and vocal segment of the population has developed a strong demand for expansion of public health services farther into the wide field of preventive medicine. In political circles a considerable progress has been indicated for support of such expansion at the federal level. If there is a corresponding phenomenon occurring at the local level, I must confess that I have failed to note its occurrence to any significant degree. Local governing bodies continue to resist the expenditure of local tax funds for public health service that might encompass an area of preventive medicine beyond the scope of the recognized basic public health services. Private medicine has contributed in no small measure to this attitude because of the spectre of "state medicine." Significant gains in development of a comprehensive program to improve total community health have been seriously retarded by this attitude. Projects such as the multiphasic survey at San Jose will serve to dispel the feeling of distrust and suspicion that private medicine has held toward public health and at the same time produce an awareness of local governing bodies to the magnitude of the total health problem of the local community. Such projects will demonstrate most forcibly that the functions of private medicine and public health supplement each other and are not in any sense competitive. It can be demonstrated that cooperative effort will tremendously enhance the effectiveness of each field of medicine toward achieving a vastly improved total community health without interference with the normal processes of private enterprise.

I confess to a feeling of keen anticipation toward the developments that this multiphasic survey portends and the community benefits to be derived from a more intelligent and coordinated use of community health resources.

Discussion by DWIGHT M. BISSELL, M.D., *San Jose*

There are several important facts which Dr. Canelo has brought out in his discussion of the multiphasic survey which was done in San Jose. There are many other factors which are less significant to the discovery of diseased conditions, but important from the viewpoint of public health administration.

While we have no knowledge of the amount of morbidity due to diabetes in this city, the mortality increased from 15 deaths due to diabetes in 1947 to 25 deaths due to diabetes in 1948. I do not believe that this is an error due to the small numbers being handled, because we have had a slight increase over previous years. In 1943, for example, 12 deaths were recorded, 18 another year. Consequently, we are led to believe that probably we are having an increase in the incidence of diabetes or that persons who have had diabetes for a number of years have had it under control but are now reaching an age when therapy is no longer effective in preventing death. Diabetes in our community is now among the first ten causes of death. Consequently, we feel that it is an important public health problem and if it is amenable to preventive measures, they should be used, provided cases can be found.

One of the large problems in this survey was to secure cooperation of many agencies including private industry. When the survey was suggested to us as a possibility, we immediately contacted the official representatives of the county medical society to see if they were interested in conducting such a survey. After due consideration, we all agreed that the county medical society, State Health Department and our city health department would be the logical agencies to conduct such a multiphasic survey. The problem was then one of securing time-off for people who were

working in industry to have these tests made. Some of the employers had to be convinced that it would be valuable to the industry for their employees to have this information. It was definitely understood in advance that this information would not be given to the employers, but would be sent to the employee's private physician. The patient-physician relationship, therefore, would be protected completely. The employer would get a summary of the findings for his plant, but would not be given information about individuals in it.

The assembly-line approach to taking these specimens for examination made the absence of an employee from work a relatively small item, but from the time he left his desk or bench and returned to it, approximately a half-hour had elapsed. In one plant where four or five hundred persons were employed, it meant that these tests would cost the employers several hundred dollars in lost work. However, eventually, by working through the plant physicians and personnel directors, we were able to secure the consent of the employers.

The next problem from our viewpoint was that of educating the employee to be willing to accept this testing service. The health education division of our department prepared a number of materials in cooperation with the personnel divisions of the plants and used about every device including plant newspapers, bulletin boards, flyers, local newspapers, information questionnaires, preliminary sign-ups, and many other devices to secure employee participation, since this was a voluntary program. It was found that the participation generally depended on the attitude of the foreman or the immediate superior of the employee. The foreman would usually be asked if he thought it were worthwhile to be stuck in the arm in order to secure this information. So it was very obviously a question of selling the plant foreman on the survey. In most of the plants the participation was very high; however, in one plant a lay-off was announced shortly before the survey was to be made and there was some feeling among the employees that persons to be laid off might be selected on the basis of the results of the tests that were to be made, even though it had been emphasized that all individual findings would be confidential.

The Santa Clara County Tuberculosis Association participated by permitting us to use its x-ray equipment in the plant for the x-raying process. Luers and other equipment were borrowed from the State Department of Public Health for the few days of the survey. Laboratory specimens were transported by messenger, as soon as they were taken, to the laboratory where they were either examined or carefully stored until they could be examined. The city public health laboratory staff was augmented and a night staff was employed to make it possible to carry on our regular public health laboratory work without interference.

In the questionnaire and identification card for each person tested, he was asked to name a family physician to receive information of any abnormal findings that the patient might have. Persons with negative results were so notified. They were instructed that this check-up did not constitute a complete examination so that they would not have a false sense of security in case they might be suffering from other diseases which would not show up abnormalities in this battery of tests. A person who had something abnormal in his findings was simply told to consult the physician he had named in his questionnaire. The physician was sent a complete report of the findings of the survey on this particular person in advance of the time that the person could arrive at the office. In this way the physician had advance knowledge as to why we had requested the person to see him. The follow-up on these persons with abnormalities was handled through the public health nursing staff of our department with the assistance and cooperation of the executive secretary of the county medical society. The executive secretary contacted all physicians who had been named, to find out if the person had reported. He gave the health department a list of those persons who needed to be visited to get them into the physician's office.

A committee of the county medical society arranged for lectures by Dr. Howard West of Los Angeles on the subject of diabetes and provided some other materials for physicians who wished it in methods of follow-up on the screening tests to determine whether a patient actually had diabetes and needed treatment. Consultation service was available through private physicians.

While the multiphasic screening test has been demonstrated as a means of detecting particularly diabetes, nephritis, and tuberculosis (since 13 previously unknown cases were picked up in this survey), to me it is equally significant that four community agencies, namely, the county medical society, the county tuberculosis association, the State Department of Public Health, and a city health department can work together with combined efforts to secure a desired result. It was a demonstration of what teamwork can do in the matter of discovery of disease as well as the follow-up of cases. I believe that it also demonstrated to the management as well as the employees of these plants that the medical profession is interested in prevention of disease through its early discovery. A great deal of the success of this multiphasic survey is attributable to the untiring efforts of Dr. Canelo who spent many long hours working out details. It has been a project with many contributors, all working to a successful conclusion.